Notice of Allowability	Application No.	Applicant(s)	
	10/796,279	EIDELMAN, SHMUEL	
	Examiner	Art Unit	
	Timothy D. Collins	3643	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address--

All claims being allowable, PROSECUTION ON THE MERITS IS (OR REMAINS) CLOSED in this application. If not included herewith (or previously mailed), a Notice of Allowance (PTOL-85) or other appropriate communication will be mailed in due course. **THIS NOTICE OF ALLOWABILITY IS NOT A GRANT OF PATENT RIGHTS.** This application is subject to withdrawal from issue at the initiative of the Office or upon petition by the applicant. See 37 CFR 1.313 and MPEP 1308.

1. ☒ This communication is responsive to *amendment filed 5/4/06*.

2. ☒ The allowed claim(s) is/are *1-41*.

3. ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
   a) ☐ All b) ☐ Some* c) ☐ None of the:
      1. ☐ Certified copies of the priority documents have been received.
      2. ☐ Certified copies of the priority documents have been received in Application No. _____ .
      3. ☐ Copies of the certified copies of the priority documents have been received in this national stage application from the International Bureau (PCT Rule 17.2(a)).

   * Certified copies not received: _____.

Applicant has THREE MONTHS FROM THE "MAILING DATE" of this communication to file a reply complying with the requirements noted below. Failure to timely comply will result in ABANDONMENT of this application.
THIS THREE-MONTH PERIOD IS NOT EXTENDABLE.

4. ☐ A SUBSTITUTE OATH OR DECLARATION must be submitted. Note the attached EXAMINER'S AMENDMENT or NOTICE OF INFORMAL PATENT APPLICATION (PTO-152) which gives reason(s) why the oath or declaration is deficient.

5. ☐ CORRECTED DRAWINGS (as "replacement sheets") must be submitted.
   (a) ☐ including changes required by the Notice of Draftsperson's Patent Drawing Review (PTO-948) attached
      1) ☐ hereto or 2) ☐ to Paper No./Mail Date _____.
   (b) ☐ including changes required by the attached Examiner's Amendment / Comment or in the Office action of Paper No./Mail Date _____.

   Identifying indicia such as the application number (see 37 CFR 1.84(c)) should be written on the drawings in the front (not the back) of each sheet. Replacement sheet(s) should be labeled as such in the header according to 37 CFR 1.121(d).

6. ☐ DEPOSIT OF and/or INFORMATION about the deposit of BIOLOGICAL MATERIAL must be submitted. Note the attached Examiner's comment regarding REQUIREMENT FOR THE DEPOSIT OF BIOLOGICAL MATERIAL.

Attachment(s)

1. ☐ Notice of References Cited (PTO-892)
2. ☐ Notice of Draftperson's Patent Drawing Review (PTO-948)
3. ☐ Information Disclosure Statements (PTO/SB/08), Paper No./Mail Date _____
4. ☐ Examiner's Comment Regarding Requirement for Deposit of Biological Material
5. ☐ Notice of Informal Patent Application
6. ☐ Interview Summary (PTO-413), Paper No./Mail Date _____ .
7. ☒ Examiner's Amendment/Comment
8. ☒ Examiner's Statement of Reasons for Allowance
9. ☐ Other _____.

EXAMINER'S AMENDMENT

1. An examiner's amendment to the record appears below. Should the changes and/or additions be unacceptable to applicant, an amendment may be filed as provided by 37 CFR 1.312. To ensure consideration of such an amendment, it MUST be submitted no later than the payment of the issue fee.

Authorization for this examiner's amendment was given in a telephone interview with Paul M. Rivard on 9/12/06. During the interview the applicant's attorney authorized the examiner to charge the account 19-0733 for the $600 in extra independent claims fees that the following examiner's amendment will incur.

The application has been amended as follows:

The previous restriction of the claims is hereby withdrawn and **all previous claims are replaced with the claims as seen in the following attachment**. Therefore the **claims of the case are now claims 1-41 as stated in the attachment labeled "Examiner's amendment to claims"**.

Claims 1-41 are allowed.

2. The following is an examiner's statement of reasons for allowance: the prior art of record all failed to show either alone and/or in combination a reaction control system for

spacecraft or kill vehicle which includes at least one pulsed detonation engine with vectorable thrust for controlling motion of the vehicle. The examiner takes the phrase reaction control system as the term of the art that is the control of the craft, but not the main propulsion. Also a kill vehicle is taken as the device as defined by the specification.

Any comments considered necessary by applicant must be submitted no later than the payment of the issue fee and, to avoid processing delays, should preferably accompany the issue fee. Such submissions should be clearly labeled "Comments on Statement of Reasons for Allowance."

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Timothy D. Collins whose telephone number is 571-272-6886. The examiner can normally be reached on M-F, 7:00-3:00, with every other Fri. off.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Peter M. Poon can be reached on 571-272-6891. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free). If you would like assistance from a USPTO Customer Service Representative or access to the automated information system, call 800-786-9199 (IN USA OR CANADA) or 571-272-1000.

T D C 9/13/06

Timothy D. Collins
Patent Examiner
Art Unit 3643

Attachment

Examiner's Amendment to Claims

1. A reaction control system for controlling motion of a spacecraft or kill vehicle, the reaction control system comprising:

at least one pulsed detonation engine comprising one or more propellant valves, an igniter, a detonation chamber, and a nozzle;

wherein the at least one pulsed detonation engine is adapted to controllably ignite detonation of a propellant to generate thrust in a predetermined vector for controlling motion of said spacecraft or kill vehicle.

2. The reaction control system of claim 1 which comprises a plurality of pulsed detonation engines capable of generating thrust in a plurality of vectors.

3. The reaction control system of claim 2 further comprising a controller for controlling operation of said plurality of pulsed detonation engines, wherein the controller is selected from the group consisting of a piezoelectric device, a thermo-fluidic device, a microelectronic mechanical system, an electromagnetic system, and combinations thereof.

4. A reaction control system for controlling motion of a spacecraft or other vehicle, the reaction control system comprising:

a plurality of pulsed detonation engines each comprising one or more propellant valves, an igniter, a detonation chamber, and a nozzle;

wherein the pulsed detonation engines are adapted to controllably ignite detonation of a propellant to generate thrust in a predetermined vector for controlling motion of said spacecraft or other vehicle;

wherein said plurality of pulsed detonation engines comprises a plurality of channels in a solid body.

5. The reaction control system of claim 4 further comprising a common valve for controllably injecting propellant into said plurality of channels.

6. A reaction control system for controlling motion of a spacecraft or other vehicle, the reaction control system comprising:

at least one pulsed detonation engine comprising one or more propellant valves, an igniter, a detonation chamber, and a nozzle;

wherein the at least one pulsed detonation engine is adapted to controllably ignite detonation of a propellant to generate thrust in a predetermined vector for controlling motion of said spacecraft or other vehicle;

wherein said at least one pulsed detonation engine comprises a detonation chamber having a groove which contains or partially contains a propellant prior to detonation.

7. The reaction control system of claim 1 wherein said at least one pulsed detonation engine comprises a detonation chamber having an igniter positioned downstream of a point at which propellant is injected.

8. The reaction control system of claim 1 wherein said at least one pulsed detonation engine comprises an igniter selected from the group consisting of a spark plug, a pyrotechnic device, and a laser.

9. The reaction control system of claim 1 further comprising an electrical energy regeneration and storage device capable of permitting remote operation of said at least one pulsed detonation engine for extended periods of time.

10. A spacecraft comprising the reaction control system of claim 1.

11. A missile intercept vehicle comprising the reaction control system of claim 1.

12. A reaction control system for controlling the motion of a spacecraft or kill vehicle, the reaction control system comprising:

at least four pulsed detonation engines arranged in a cruciform for selectively generating thrust in at least four vectors, wherein each of said pulsed detonation engines

comprises electronically controlled propellant valves, an igniter, a detonation chamber, and a nozzle;

a controller for selectively actuating said at least four pulsed detonation engines, the controller comprising at least one of a piezoelectric device, a thermo-fluidic device, an electromagnetic device, and a microelectronic mechanical system.

13. A spacecraft or kill vehicle comprising the reaction control system of claim 12.

14. A method of controlling motion of a spacecraft or kill vehicle with a reaction control system, the method comprising generating thrust in a predetermined vector by controllably igniting detonation of a propellant in at least one pulsed detonation engine in the reaction control system of claim 1.

15. The method of claim 14 which comprises controllably generating thrust in a plurality of vectors by controllably actuating a plurality of pulsed detonation engines in said reaction control system.

16. The method of claim 14 wherein said propellant is injected into a detonation chamber of the pulsed detonation engine during a controlled injection time of from about 0.01 to 1,000 msec.

17. The method of claim 16 wherein the controlled injection time is from about 0.1 to about 10 msec.

18. The method of claim 14 wherein said igniting detonation is delayed from about 0.1 to about 100 msec following injection of said propellant into a detonation chamber of said pulsed detonation engine.

19. The method of claim 18 wherein said igniting detonation is delayed from about 0.1 to about 10 msec following injection.

20. The method of claim 14 wherein detonation velocity in said at least one pulsed detonation engine is limited to about 1 to about 5 km/s.

21. The method of claim 20 wherein the detonation velocity is limited by adding material to the propellant to reduce propellant density.

22. The method of claim 14 wherein said propellant comprises a liquid propellant having a density of from about 0.001 to about 0.5 g/cc.

23. The method of claim 14 wherein said propellant comprises a gas containing particles having an average particle size of about 10 μm or less and a liquid or gaseous oxidizer.

24. The method of claim 23 wherein said propellant comprises aluminum particles.

25. The method of claim 23 wherein said propellant comprises a suspension of magnesium particles.

26. The method of claim 14 wherein said propellant comprises gaseous aluminum and a liquid or gaseous oxidizer.

27. The method of claim 14 wherein propellant comprises a suspension of gaseous magnesium.

28. The method of claim 14 wherein said propellant comprises nanoscale particles.

29. The method of claim 28 wherein said propellant comprises a liquid propellant and wherein said nanoscale particles are present in a concentration of from about 0.1 to about 1 wt% effective to activate the propellant.

30. The method of claim 28 wherein the nanoscale particles are present in the propellant in a concentration of from about 1 to 15 wt% effective to reduce detonation velocity and pressure.

31. The method of claim 28 wherein the nanoscale particles increase or decrease the dielectric properties of the propellant.

32. The method of claim 28 wherein the nanoscale particles absorb fuel on their surfaces, thereby rendering the nanoscale particles detonable.

33. The method of claim 14 wherein said propellant comprises one or more carbon structures selected from the group consisting of fullerines, nanotubes, and nanoscale diamond.

34. The method of claim 14 wherein fuel and oxidizer are macroscopically mixed by impingement of fuel and oxidizer streams.

35. The method of claim 34 further comprising microscopically mixing said fuel and oxidizer.

36. The method of claim 14 wherein said propellant is injected into and dispersed within a detonation chamber and ignited while in the dispersed phase.

37. The method of claim 14 wherein said propellant is contained or partially contained in a groove in a detonation chamber prior to detonation.

38. The method of claim 14 wherein said propellant is injected into a detonation chamber by forming a thin layer of propellant along inner surfaces of the detonation chamber.

39. A reaction control system for controlling motion of a spacecraft or other vehicle, the reaction control system comprising:

at least one pulsed detonation engine comprising one or more propellant valves, an igniter, a detonation chamber, and a nozzle;

wherein the at least one pulsed detonation engine is adapted to controllably ignite detonation of a propellant to generate thrust in a predetermined vector for controlling motion of said spacecraft or other vehicle;

wherein the length of the at least one pulsed detonation engine is from about 5 to about 100 mm.

40. The reaction control system of claim 39 wherein the length is from about 5 to about 55 mm.

41. A reaction control system for controlling motion of a spacecraft or other vehicle, the reaction control system comprising:

at least one pulsed detonation engine comprising one or more propellant valves, an igniter, a detonation chamber, and a nozzle;

wherein the at least one pulsed detonation engine is adapted to controllably ignite detonation of a propellant to generate thrust in a predetermined vector for controlling motion of said spacecraft or other vehicle;

wherein the at least one pulsed detonation engine comprises a detonation chamber having a diameter of from about 0.01 mm to 10 mm.